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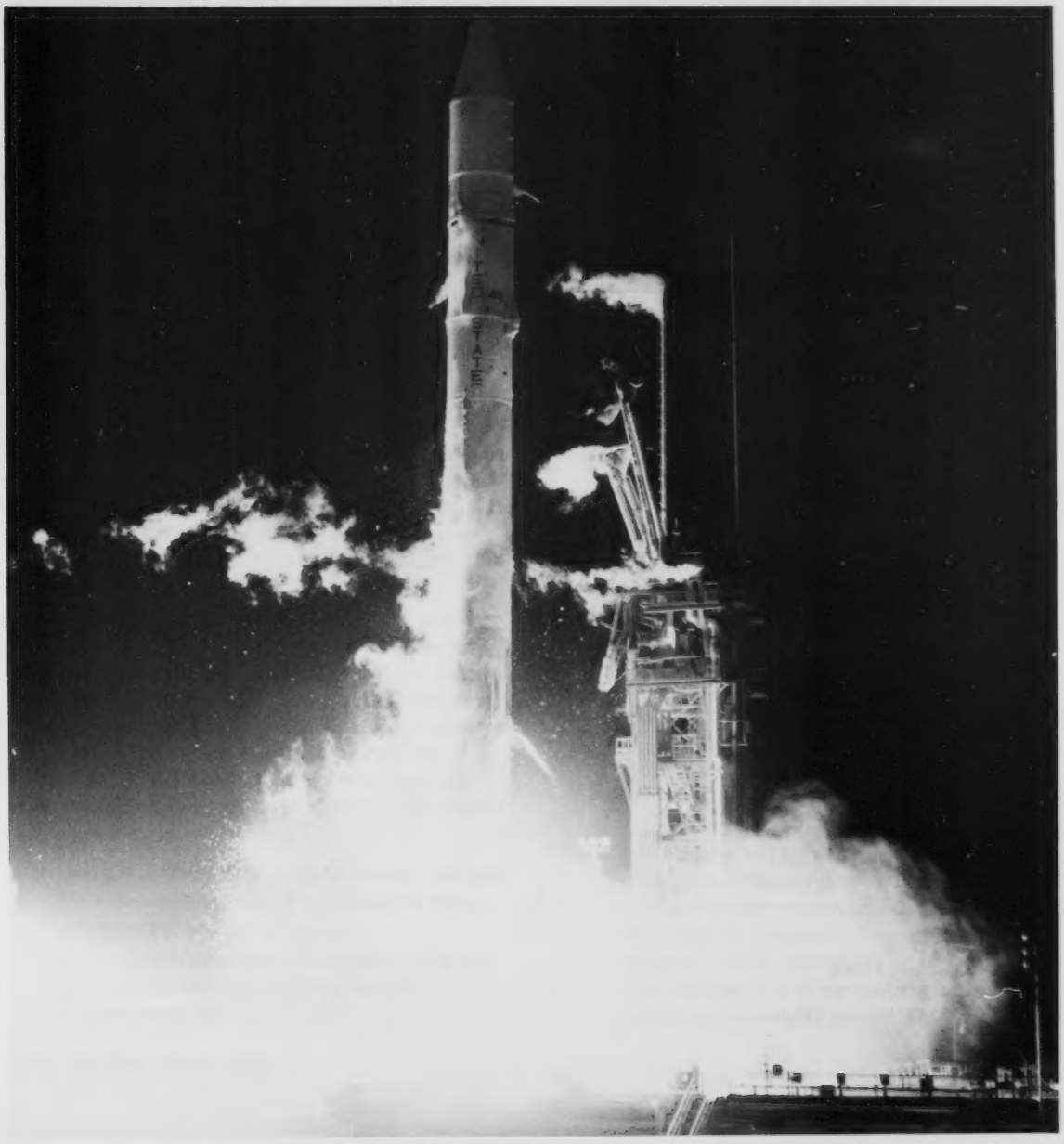

## Cover

**First of the 80s**—The third in a series of Fleet Satellite Communications satellites was the first NASA launch of the new year and the decade. On a clear night, at 8:26 p.m. EST, January 17, FLTSATCOM-C roared aloft from Cape Canaveral aboard an Atlas-Centaur rocket in a launch described as "near perfect". Headed for an apogee of 35,813 kilometers and perogee of 167.4 km, FLTSATCOM-C became part of the versatile communications system for U.S. military units throughout the world and is now controlled by the Air Force. Launch witnesses at the Cape, even those who had experienced the ascent of a Saturn V, called the FLTSATCOM departure a spectacular sight, with the vehicle glowing "like a star" until out of sight—good omen for the 1980s.

**Correction**—The research craft shown on the cover of the February Activities was a Drone Aeronautical Structural Test vehicle, not a HiMAT aircraft as described.

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# Letter from Washington

Dear Colleagues:

The President's budget for NASA in fiscal year 1981 is a positive budget and one which moves us forward into the 1980s across a broad front of vital activities in space transportation, space science, and in the practical applications of space technology and aeronautics.

In the eighties we look forward to operational status for the Space Shuttle fleet; large increases in the use of satellites for communications and for remote sensing of land, ocean, and atmospheric conditions; continued improvement in performance, safety, energy efficiency, and environmental compatibility of aircraft; and dramatic new increases in our knowledge and understanding of the universe.

The President has proposed a NASA budget totalling $5.737 billion for FY 1981, and a fiscal year 1980 supplemental appropriation of $300 million for Space Shuttle development. This budget will build on NASA's basic strengths in a time of serious national economic stresses and heightening international tensions.

It provides significant initatives in space science and applications. It reflects the Administration's commitment to a strong, multi-faceted space program in the 1980s. It supports the President's space policy goals of maintaining U.S. leadership in space science and applications as well as exploiting fully the capabilities of the Space Shuttle for all national objectives. With Congressional approval, this budget will support:

—*initial test flights of the Space Shuttle,* culminating a decade-long, highly sophisticated design, development and test program;

—*a Shuttle orbiter production* schedule that will meet critical civil and military launch requirements:

—*continued emphasis on a broadly-based space science* program featuring:

- a new mission, the Gamma Ray Observatory (GRO), that will provide a major increase in our knowledge of the high energy universe and improve our knowledge of gamma ray source positions by a factor of 50 to 100, a powerful new tool for the study of high energy phenomena;
- development effort on the restructured 1984 Galileo mission, to capitalize on the superb performances of Voyagers I and II at Jupiter;
- continued work on the U.S. spacecraft for the 1983 U.S./Europe International Solar Polar dual spacecraft mission;

—*important emphasis on space applications,* including:

- focus of our Landsat land sensing effort to support the President's recent decision on implementing a fully operational satellite-based land remote sensing system under Department of Commerce leadership; this capability will allow enhanced forecasting of production of major crops, location of vital petroleum and mineral resources, and increased monitoring of environmental quality.
- initiation of the National Oceanic Satellite System (NOSS), a tri-agency flight program that will demonstrate operational global sea surface observation capabilities from space; NOSS will bring space remote sensing capabilities to the ocean, complementing similar capabilities over air and land. Global marine forecasting capability via improved weather satellites for support of maritime activities is also likely within the 1980s including optimum ship routing based on improved forecasting.

  Improved satellite-based forecasting of large general atmospheric circulation provides the basis for local weather forecasts, including forecasts of phenomena such as severe storms. The forecasting of these localized, near-time phenomena will be a focus of the 1980s. It may be expected that by the end of the 1980s a greatly improved data base will exist, including an organized climate monitoring program, better description of present trends, and identification of most of the important factors influencing climate.

- expanded communication satellite research and development studies and advanced technology for experimental wideband satellite communications. To enlarge a bit, the next decade of satellite communications will show as rapid progress as the past, which saw the creation of a global network of satellites and Earth stations connecting eighty countries on six continents. An educated guess as to the total expected demand for satellite circuits for present and projected new uses by the year 2000, including domestic and regional as well as international traffic, is that a better than ten-fold capacity increase is required. These new systems will exploit the Shuttle launch capability and will demonstrate a new class of satellites having more telecommunication capacity, high-speed digital transmission, and longer life.

—*In aeronautics we will* continue advanced work on more efficient and effective aircraft featuring:

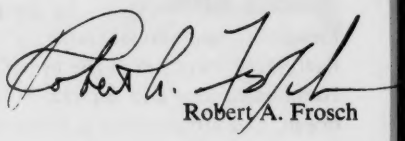
- a comprehensive program of research and technology;
- vigorous flight test programs for the Tilt Rotor and Quiet Shorthaul Research Aircraft and for the Highly Maneuverable Aircraft Technology Vehicle;
- important new thrusts in technology for advanced rotorcraft;
- emphasis on advanced variable cycle engine technology, and;
- continued progress in aircraft energy efficiency technology for the next generation of transport aircraft, including a next step in advanced turboprop system technology. While technology is only one of several factors influencing the evolution of commercial aircraft, it is a key factor in that it directly affects equipment costs, operating costs, safety, comfort, fuel economy, and other primary considerations. As an example of the potential impact of improved technology, the free world market for new transport aircraft between 1980–1989 has been estimated to amount to over 5000 aircraft representing a total investment approaching $200 billion.

—continued application of NASA expertise to national energy problems;

—the necessary resources for our critical in-house scientific, technical and administrative staffs and facilities to assure successful programs in aeronautics and space.

I think you will agree from its highlights that the recommended budget for FY 1981 is more than adequate to move our agency ahead in its prescribed tasks of expanding human knowledge of the Earth, the solar system and the universe; of exploiting the special environment of space for the benefit of humanity; and of assuring continued U.S. leadership in space and aeronautical technology. I think you will agree also that it puts us on a solid and sensible course that will carry us into the most challenging and interesting decade yet in space and aeronautics.

Sincerely,



Robert A. Frosch

## Budget Proposes Gamma Ray Satellite

The Gamma Ray Observatory, a proposed new start in NASA's fiscal 1981 budget, is designed to explore sources of gamma rays in space—the most energetic form of radiation known. The Earth-orbiting observatory, planned for launch in 1985, will carry instruments which will detect gamma rays in a variety of forms—very high energy gamma rays from pulsars, nuclear gamma rays and gamma ray bursts.

Information returned is expected to provide a much deeper understanding of the nature of supernovas, pulsars, quasars and radio galaxies, the character of the universe at an early time, and the possible existence of antimatter in the universe.

Scientists also hope to learn more about the incredibly dense matter which makes up such objects as neutron stars—matter so compressed that a teaspoonful of it would weigh millions of tons. The data may also shed more light on the nature of gamma ray bursts—erratic pulses of gamma rays that appear every month or so and flash across the solar system. Their origin is a mystery.

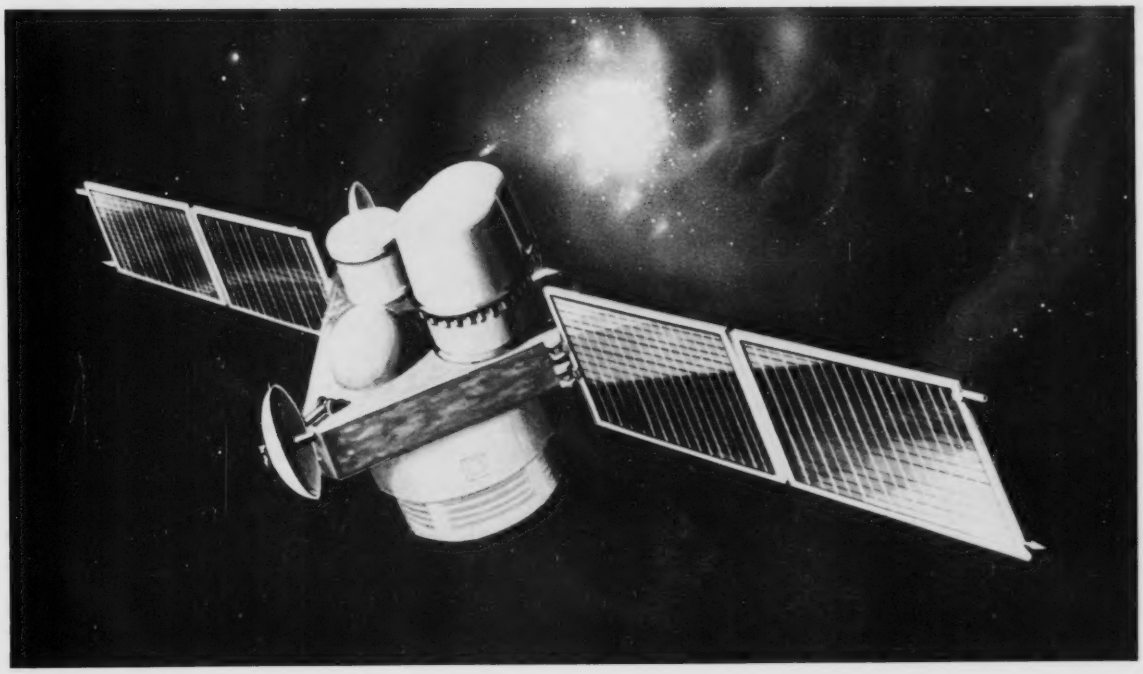
Like X-rays, gamma rays are a form of electromagnetic radiation (as is ordinary light), but they have extremely high energy and correspondingly short wavelengths (less than $10^{-11}$ centimeters). At maximum strength, a gamma ray unit packs several million times as much energy as a comparable unit of visible light.

Unlike X-rays, however, which are typically emitted by hot gas, gamma rays are believed to come from the core of the phenomenon, produced by special nuclear processes. Gamma ray astronomy allows scientists to investigate these special processes.

Until recently all astronomy observations were of atoms, ions and molecules, and their emissions. Gamma rays were recognized after World War II as an important aspect of space research, but work in this field was slow. A long program of balloon research proved rather disappointing, with only hints that gamma ray sources were being detected.

Then a small experiment on an Orbiting Solar Observatory detected the first certain gamma rays. This gave scientists the confidence to launch in 1972 the Small Astronomy Satellite 2 with a small detector for very high energy gamma rays. This spacecraft, along with the European spacecraft COS-B (1975), and the first High Energy Astronomy Observatory, provided the basic data which will be exploited by the more powerful Gamma Ray Observatory.

The observatory will be managed by Goddard Space Flight Center and the satellite will be carried into a planned orbit of 400 to 500 kilometers by the Space Shuttle.



## Tile Repair Kit for Shuttle

A Space Shuttle on-orbit thermal tile repair kit is now under development for NASA. The kit is designed for use by Shuttle crews to repair possible damage to any of the thousands of ceramic-based tiles which cover the orbiter and protect it from intense heat during reentry into the Earth's atmosphere. The kit will not be flown on the first test flight but will be held in reserve for possible use on later flights where the launch environment will approach design conditions.

A letter contract signed by NASA and Martin Marietta Aerospace, Denver Division, is preliminary to an official contract award and authorizes the aerospace manufacturer to proceed with immediate design and development of the tile repair kit. Estimated value of the contracts is $2.1 million.

The letter contract followed studies conducted by four aerospace companies for the NASA Johnson Space Center, Houston. Proposals were received from General Electric Co., Philadelphia, and Martin Marietta Aerospace. The contract calls for Martin to design and fabricate three repair kits for delivery to NASA by September. Two of the units are for flight use and the third is for astronaut training.

A space-suited astronaut would don a backpack maneuvering unit in the Shuttle cargo bay, inspect the outside of the orbiter, and if necessary, use the kit to apply ablative repair materials.

## NASA to Buy Spacelab From ESA

The National Aeronautics and Space Administration has signed a $183,960,000 contract calling for manufacture and delivery in 1984 of a second Spacelab by the European Space Agency.

The first Spacelab, a reusable spaceborne scientific laboratory, already is being designed and built by ESA for delivery in time to be aboard an early operational flight of the U.S. Space Shuttle.

Funding for development of the Spacelab concept and manufacture of the first flight unit is provided by ESA member nations and is estimated to exceed $850 million.

In return for the contribution of the first flight unit, NASA agreed to procure from the European agency a second flight unit and others if needed in the future.

The second Spacelab, like the first, will be built by the ERNO industrial facility in Bremen, Germany, prime contractor to the European Space Agency.

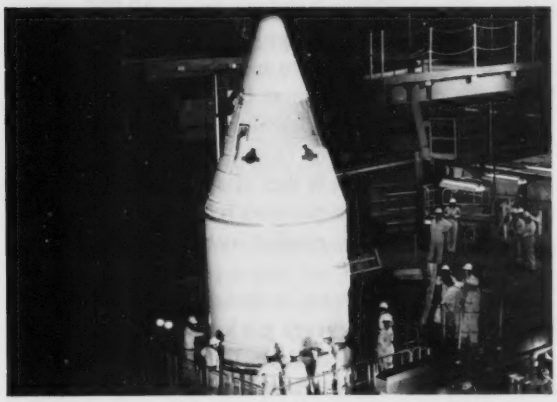
At least 26 subcontractors, in the European Space Agency member nations of Germany, France, Italy, United Kingdom, Spain, Belgium, The Netherlands, Switzerland, Austria and Denmark, as well as in the United States, are expected to be involved in producing components and subassemblies of the second Spacelab.

Spacelab is to be a major element of the NASA Space Transportation System being developed to transport people and material economically and

**Aviation Tackles Tile Factor**—Providing an example of NASA program interdependence, an F-15 research aircraft is shown flight testing the Space Shuttle's thermal protection tiles over California. In tests conducted by the Dryden center, the tiles on the F-15's right wing (dark section) are simulating the leading edge of the Shuttle Orbiter's wing. The tile sections will eventually be submitted to almost one and one-half the dynamic pressure that the Shuttle will attain during launch. Further testing will involve both the F-15 and F-104 aircraft, as part of the overall verification of the various Shuttle systems.

routinely between the ground and Earth orbit. Spacelab will be transported aboard the Space Shuttle for Earth-orbital missions lasting 7 to 30 days. It will remain attached to the orbiter throughout each mission. Spacelab will have facilities and equipment similar to laboratories on Earth but adapted for zero gravity.

**Study in Concentration**—Members of the Orbiter Integrated Test team are intent on their monitors during the recent Kennedy Space Center simulated flight. The team is made up of some 120 engineers and technicians from both NASA and aerospace contractors and they monitor progress of the critical operational test in the Launch Control Center's Firing Room 1. The group is comparable in size to the launch team that will be used on early Shuttle missions.



**Topping Off the Left Booster**—The launch of the Space Shuttle comes a step closer at the Kennedy center with the mating of the left Solid Rocket Booster (SRB) forward assembly, consisting of nose cap, frustum and forward skirt. Topping off the left Solid Booster is an integral part of the "stacking" process and the complete SRB assembly is scheduled for rollout in April. Both Twin Boosters produce some six million pounds of thrust at liftoff.

## Solar Maximum Mission

*In the second launch of the new year, a four-meter-long spacecraft carrying a wide range of scientific instruments was sent into orbit from the Kennedy Space Center aboard a Delta rocket. The date was Feb. 14. A NASA Fact Sheet explained the mission:*

A major step toward understanding the violent nature of the Sun and its possible effects on Earth is the promise of the Solar Maximum Mission.

Solar flares are expected to occur most frequently near the maximum of the Sun's 11-year cycle expected in 1980–81. The flares are a complex phenomenon and no two are exactly alike.

The Solar Maximum Mission will use a variety of observation methods, including satellites, sounding rockets and ground-based instruments, to study solar flares through their individual life histories.

The mission's satellite is designed to provide scientists with observations of solar flares (violent eruptions on the Sun's surface) over a wide band of wavelengths in the ultraviolet, X-ray and gamma ray regions of the electromagnetic spectrum. Through coordinated observations at many different wavelengths, scientists expect to obtain many clues about the causes of solar flares and how they might be predicted.

Although the spacecraft will concentrate on solar flare activity, instruments are expected to measure also the Sun's radiation to within one-tenth of one percent of the total output over a period of one year. According to computer model predictions of the response of Earth's atmosphere to solar radiation, such a precise measurement should be sufficient to definitely establish whether changes in total solar heat output are sufficient to affect climate and weather.

The satellite will operate in a 574 kilometer-high circular orbit with a planned incline 28.6 degree to the Equator. Solar Maximum takes 96 minutes to complete an orbit. At the end of its mission, the satellite may be retrieved by the Space Shuttle.

## U.S., China Agree on Landsat Station

NASA and the Chinese Academy of Sciences signed a Memorandum of Understanding Jan. 24 covering China's participation in the experimental Landsat program. China will establish a ground station in the Beijing area to read out Earth resources data from Landsat D.

The ground station is to be purchased from U.S.

industry under the Understanding on Cooperation in Space Technology of Jan. 31, 1979. The Landsat Memorandum of Understanding is the first formal agreement in the space area since the normalization of U.S.-China relations.

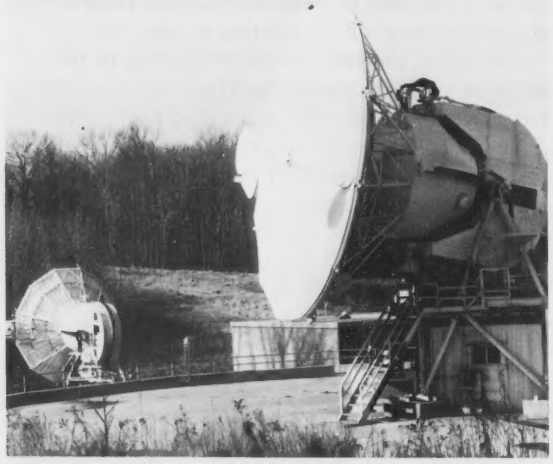
The signing came during a visit to China by a delegation headed by Dr. Frank Press, Presidential Science Advisor, which included NASA Administrator, Dr. Robert A. Frosch.

The agreement, which parallels those signed with a number of other foreign ground station operators, provides that the Chinese Academy of Sciences will make Landsat data it receives openly and uniformly available to others on a basis similar to the distribution policies followed by NASA and other U.S. agencies. The Academy will help share in the cost of operating the Landsat satellites by paying an annual access fee of $200,000, beginning six months after the Beijing station begins receiving data.

Six Landsat ground stations already are in operation outside the U.S.: two in Canada and one each in Brazil, Italy, Sweden and Japan. New ground stations in Australia and India now are receiving test data and soon will be operational. Another station is under construction in Argentina, while a number of others are in the planning stages elsewhere.

U.S. ground stations for Landsat are located at Fairbanks, Alaska; Goldstone, Calif.; and at the NASA Goddard Space Flight Center, Greenbelt, Md.

Landsat D is expected to be operational in 1982. Landsat 3, launched in March 1978, still is operating. Landsat data are being used by scientists and local officials in the U.S. and more than 100 foreign countries for a wide variety of applications ranging from crop inventories to flood assessment and mineral exploration. The Beijing ground station is expected to make significant contributions to Chinese modernization in such areas as agriculture, forestry and mining.



**Satellite Antenna Slated for China**—A tracking station for the Landsat Earth resources satellite, similar to this one at the NASA/Goddard center in Greenbelt, Md., will be built in mainland China under a recent agreement. The Chinese ground antenna is expected to incorporate even more sophisticated equipment than the Greenbelt facility, which receives signals from Landsat's Return Beam Vidicon Cameras and Multi-Spectral Scanner.

## Space Superbubble Light Years Away

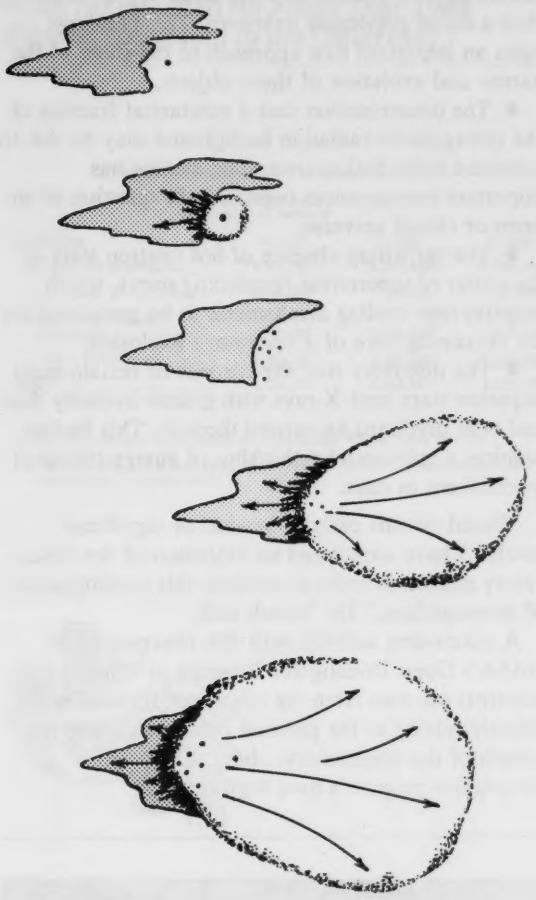
A superhot, superbubble of gas, apparently confined to a gigantic, glowing ring or shell some 6,000 light years away from Earth and some 1,200 light years in diameter, has been discovered, centered in the prominent summer constellation Cygnus, the Northern Cross.

The discovery was made from satellite data by Dr. Webster Cash, Laboratory for Atmospheric and Space Physics at the University of Colorado, Boulder, and his co-investigator, Dr. Philip Charles, Space Science Laboratory, University of California, Berkeley. They used X-ray data from NASA's Earth-orbiting High Energy Astronomy Observatory 1.

Dr. Cash reported the sphere contains enough superheated gas at 2 million degrees Celsius (3.5 million degrees Fahrenheit), to create 10,000 new stars like our Sun. Its energy output is equal to 10 times the amount of the entire energy emitted by our Sun since its formation some five billion years ago. There is no known phenomenon in the galaxy with that kind of energy. The most powerful explosion known to astronomers is that of a supernova, an exploding star, but a supernova releases only about 3 percent of the energy needed to make the superbubble.

What puzzles scientists is finding an answer to how this huge amount of energy got locked up in this gigantic halo in the first place. Dr. Cash thinks there may have been a series of explosions of supernovas in the region over the past three million years, perhaps anywhere from 30 to 100 which, in sequence, together created the superheated superbubble.

Here's how it may have happened according to Dr. Cash: A huge cool gas cloud, measuring 800 by 3,000 light years, known as the Great Rift of Cygnus can be seen obscuring the Milky Way in Cygnus on a



**Evolution of Superbubble**—Schematic shows, top to bottom, the five steps in an evolutionary process that took eons. First, cloud and star; star becomes supernova and shock wave strikes cloud; new stars are formed from cloud; new stars become supernovas and create the bubble, which starts to inflate; and finally, as more stars are formed, the superbubble grows even larger.

dark night. This dark cloud has enough material to make five million stars and lies right next to the observed superbubble. In fact, it obscures the central part of the bubble as seen from Earth.

About three million years ago a supernova exploded and impacted the gas cloud with part of the star blowing into interstellar space. As the force of the explosion moved through the cloud, the compression caused the gas to coalesce about 100,000 years later, forming a group of perhaps 1,000 stars of which number about 10 would become supernovas. Supernova stars have a lifetime of only about one million years.

These 10 stars would explode, in turn, pushing the gas cloud back farther and causing more stars to form along its edge as the compression on the cloud continued. At the same time, the force of the explosions away from the cloud caused a sweeping effect on interstellar space making a shell or bubble of superheated hydrogen material that became the immense superheated, superbubble we see in X-ray data today.

Dr. Cash said these chains of star formation are a major mechanism for making new stars. "The Sun may well have been formed at the edge of a similar bubble," he said. The reason the huge halo was never spotted before is because, Dr. Cash says, "it flows so energetically that it cools through emission of X-rays instead of more normal emissions that can be seen in the optical or infrared regions of the spectrum." The hotter a substance is, the shorter its radiation wave length.

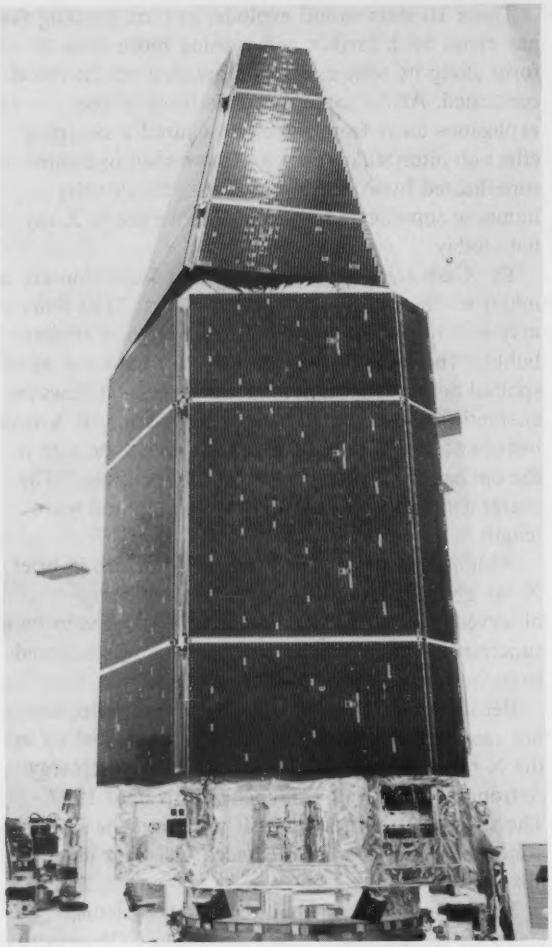
Although parts of it had been seen before in brief X-ray glimpses, no one knew what was being observed. One part, for example, was thought to be a supernova remnant, while another part was believed to be hot gas escaping from the galaxy.

Because of its large size, the bubble or halo, was not seen in its entirety until it could be picked up in the X-ray sweep provided first by the High Energy Astronomy Observatory launched in August 1977. The spacecraft burned up as it reentered the Earth's atmosphere last March after accomplishing its mission.

The observatory was built by TRW Systems, Redondo Beach, Calif. The High Energy Observatory Project management is under the direction of NASA's Marshall Space Flight Center. The cosmic X-ray experiment instrument from which the data were made available to the two scientists was built under the direction of Dr. Elihu Boldt, NASA Goddard Space Flight Center, and Dr. Gordon Garmire, California Institute of Technology, Pasadena.

## HEAO 2 to Keep Working

High Energy Astronomy Observatory 2, originally scheduled to end operations after one year in Earth orbit, will continue to search the skies for information about such objects as quasars, pulsars, exploding galaxies and black holes. NASA officials decided that the many significant findings attributed to HEAO 2—which carries the largest X-ray telescope every built—warranted an extension of its space science



HEAO 2 before encapsulation in its payload shroud.

mission beyond the projected lifetime of 11 months. The satellite is popularly known as the Einstein Observatory.

"The performance of the observatory has been excellent throughout the first year of the mission," said Dr. Thomas A. Mutch, NASA Associate Administrator for Space Science. "The operation of the scientific instruments has met or exceeded our expectations."

The instruments continue to operate satisfactorily. A solid state spectrometer, which performed exceptionally well, has depleted its cryogens, and ceased operating, as expected.

Among the most significant new findings from the observatory are the following:

- The X-ray observation of more than 60 known quasars, ranging from relatively nearby to the most distant objects known, and the discovery of more than a dozen previously unknown. These findings open an important new approach to the study of the nature and evolution of these objects.
- The determination that a substantial fraction of the extragalactic radiation background may be due to scattered individual sources. This finding has important consequences regarding the question of an open or closed universe.
- The surprising absence of hot neutron stars at the center of supernovas (exploding stars), which requires new cooling mechanisms to be postulated for the remaining core of a supernova explosion.
- The discovery that the coronas of certain main sequence stars emit X-rays with greater intensity than had been predicted by current theories. This finding requires a substantial rethinking of energy-transport mechanisms in stars.

"Based on this early indication of significant results, I have authorized an extension of the observatory mission in order to continue this exciting series of investigations," Dr. Mutch said.

A continuing activity with the observatory is NASA's Guest Investigator Program in which scientists use data from the spacecraft for studies not directly related to the planned objectives. Since the launch of the observatory, about 400 guest investigator proposals have been received.

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**Agency Cited for Civil Service Reform**—Singular honor came to NASA in January as Deputy Administrator Dr. Alan M. Lovelace accepted the first Udall-Derwinski Award for Civil Service Reform from Rep. Morris K. Udall, D-Ariz. (center) and Rep. Edward J. Derwinski, R-Ill. The National Aeronautics and Space Administration was recognized for initiative, excellence and leadership in its conversion to the Senior Executive Service. The awards ceremony, citing individuals and agencies for their efforts in implementing the Civil Service Reform Act of 1978, was held at the Department of State.

# NASA Budget Plan for Fiscal Year 1981
# (Figures submitted to the Congress)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

| BUDGET PLAN | FY 1979 | FY 1980 | FY 1981 |
|---|---|---|---|
| Research and development..... | 3,477,200 | 4,107,500[a/] | 4,569,500 |
| Construction of facilities... | 147,500 | 156,100 | 120,000 |
| Research and program management..... | 933,808 | 1,006,186[b/] | 1,047,154 |
| TOTAL BUDGET PLAN..... | 4,558,508 | 5,269,786 | 5,736,654 |
| OUTLAYS..... | 4,196,472 | 5,012,600 | 5,439,700 |

a/ Includes proposed supplemental of $300,000,000 for the Space Shuttle.

b/ Includes proposed supplemental of $46,286,000 to cover revised salary rates implemented in October 1979.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT PROGRAMS

BUDGET PLAN
(Thousands of Dollars)

| Cognizant Office and Program | FY 1979 | FY 1980 | FY 1981 |
|---|---|---|---|
| SPACE TRANSPORTATION SYSTEMS | 2,011,600 | 2,403,300 | 2,738,200 |
| Space Shuttle..... | 1,638,300 | 1,886,000[a/] | 1,873,000 |
| Space flight operations..... | 299,700 | 446,600 | 809,500 |
| Expendable launch vehicles..... | 73,600 | 70,700 | 55,700 |
| SPACE SCIENCE | 505,400 | 600,800 | 668,000 |
| Physics and astronomy..... | 282,900 | 337,100 | 438,700 |
| Planetary exploration..... | 182,400 | 219,900 | 179,600 |
| Life sciences..... | 40,100 | 43,800 | 49,700 |
| SPACE AND TERRESTRIAL APPLICATIONS | 283,900 | 343,900 | 394,800 |
| Space applications..... | 274,800 | 331,800 | 381,700 |
| Technology utilization..... | 9,100 | 12,100 | 13,100 |
| AERONAUTICS AND SPACE TECHNOLOGY | 376,400 | 427,100 | 409,500 |
| Aeronautical research and technology.. | 264,100 | 308,300 | 290,300 |
| Space research and technology..... | 107,300 | 115,800 | 115,200 |
| Energy technology..... | 5,000 | 3,000 | 4,000 |
| SPACE TRACKING AND DATA SYSTEMS | 299,900 | 332,400 | 359,000 |
| TOTAL..... | 3,477,200 | 4,107,500 | 4,569,500 |

a/ Includes proposed supplemental of $300,000,000 for the Space Shuttle.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE TRANSPORTATION SYSTEMS

BUDGET PLAN
(Thousands of Dollars)

| | FY 1979 | FY 1980 | FY 1981 |
|---|---|---|---|
| SPACE SHUTTLE | 1,638,300 | 1,886,000[a/] | 1,873,000 |
| Design, development, test and evaluation..... | (1,270,300) | (1,030,500) | (683,000) |
| Orbiter..... | 727,800 | 560,900 | 320,900 |
| Main engine..... | 172,700 | 140,600 | 145,700 |
| External tanks..... | 104,800 | 79,400 | 48,000 |
| Solid rocket boosters..... | 115,400 | 61,200 | 14,000 |
| Launch and landing..... | 149,600 | 188,400 | 154,400 |
| Changes/systems upgrading..... | (---) | (100,000) | (150,000) |
| Production..... | (368,000) | (755,500) | (1,040,000) |
| Orbiter..... | 264,500 | 572,600 | 768,200 |
| Main engine..... | 75,500 | 123,600 | 121,500 |
| Launch and landing..... | 7,000 | 16,400 | 40,400 |
| Spares and equipment..... | 21,000 | 42,900 | 109,900 |
| SPACE FLIGHT OPERATIONS | 299,700 | 446,600 | 809,500 |
| Space transportation system operations capability development..... | 64,500 | 54,100 | 89,000 |
| Spacelab..... | 26,700 | 38,800 | 151,700 |
| Space transportation system operations. | 24,300 | 148,100 | 374,500 |
| Development, test and mission support.. | 177,200 | 172,600 | 183,500 |
| Advanced programs..... | 7,000 | 13,000 | 10,800 |
| EXPENDABLE LAUNCH VEHICLES | 73,600 | 70,700 | 55,700 |
| Scout..... | 10,600 | 5,100 | 2,200 |
| Centaur..... | 17,300 | 18,300 | 5,600 |
| Delta..... | 45,700 | 46,100 | 47,900 |
| Atlas-F..... | --- | 1,200 | --- |
| TOTAL SPACE TRANSPORTATION SYSTEMS... | 2,011,600 | 2,403,300 | 2,738,200 |

a/ Includes proposed supplemental of $300,000,000.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SCIENCE

BUDGET PLAN
(Thousands of Dollars)

| | FY 1979 | FY 1980 | FY 1981 |
|---|---|---|---|
| PHYSICS AND ASTRONOMY | 282,900 | 337,100 | 438,700 |
| High energy astronomy observatories development..... | 10,647 | 2,100 | --- |
| Solar maximum mission development..... | 16,700 | 3,100 | --- |
| Space telescope development..... | 79,200 | 112,700 | 119,300 |
| International solar polar mission development..... | 12,500 | 47,900 | 82,600 |
| Gamma ray observatory development..... | --- | --- | 19,100 |
| Shuttle/Spacelab payload development and mission management..... | 34,900 | 40,900 | 72,100 |
| Explorer development..... | 31,288 | 32,300 | 33,000 |
| Mission operations and data analysis... | 25,653 | 37,100 | 38,900 |
| Research and analysis..... | 44,005 | 34,100 | 42,800 |
| Suborbital programs..... | 28,207 | 26,900 | 30,900 |
| PLANETARY EXPLORATION | 182,400 | 219,900 | 179,600 |
| Galileo development..... | 78,700 | 116,100 | 63,100 |
| Mission operations and data analysis... | 59,300 | 58,800 | 64,800 |
| Research and analysis..... | 44,400 | 45,000 | 51,700 |
| LIFE SCIENCES | 40,100 | 43,800 | 49,700 |
| Life sciences flight experiments..... | 15,700 | 16,600 | 19,200 |
| Research and analysis..... | 24,400 | 27,200 | 30,500 |
| TOTAL SPACE SCIENCE..... | 505,400 | 600,800 | 668,000 |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE AND TERRESTRIAL APPLICATIONS

BUDGET PLAN
(Thousands of Dollars)

| | FY 1979 | FY 1980 | FY 1981 |
|---|---|---|---|
| SPACE APPLICATIONS | 274,800 | 331,800 | 381,700 |
| RESOURCE OBSERVATIONS | 139,400 | 145,203 | 162,300 |
| Landsat-D | 97,500 | 98,663 | 64,300 |
| Operational land observing system | --- | --- | 16,000 |
| Magnetic field satellite | 3,900 | 1,600 | 500 |
| AgRISTARS | --- | 16,000 | 33,200 |
| Shuttle/Spacelab payload development | 6,200 | 1,850 | 2,000 |
| Applied research and data analysis and related activities | 30,800 | 27,090 | 46,300 |
| Completed projects | 1,000 | --- | --- |
| ENVIRONMENTAL OBSERVATIONS | 67,750 | 109,470 | 137,600 |
| Earth radiation budget experiment | 7,000 | 17,000 | 29,000 |
| Halogen occulation experiment | 3,600 | 8,000 | 6,000 |
| National oceanic satellite system | --- | --- | 5,800 |
| Shuttle/Spacelab payload development | 7,750 | 9,600 | 8,200 |
| Advanced research and data analysis and related activities | 41,076 | 74,370 | 88,600 |
| Completed projects | 8,324 | 500 | --- |
| APPLICATIONS SYSTEMS | 13,950 | 24,547 | 18,100 |
| TECHNOLOGY TRANSFER | 10,700 | 10,087 | 12,500 |
| MATERIALS PROCESSING IN SPACE | 20,400 | 19,768 | 22,200 |
| Space processing applications rocket project | 3,600 | 2,100 | --- |
| Shuttle/Spacelab payload development | 11,950 | 11,218 | 10,500 |
| Applied research and data analysis | 4,850 | 6,450 | 11,700 |
| SPACE COMMUNICATIONS | 22,600 | 22,725 | 29,000 |
| Search and rescue | 8,000 | 5,000 | 2,300 |
| Shuttle/Spacelab payload development | 1,200 | 1,660 | --- |
| Applied research and data analysis and related activities | 13,400 | 16,065 | 26,700 |
| TECHNOLOGY UTILIZATION | 9,100 | 12,100 | 13,100 |
| TOTAL SPACE AND TERRESTRIAL APPLICATIONS | 283,900 | 343,900 | 394,800 |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AERONAUTICS AND SPACE TECHNOLOGY

BUDGET PLAN
(Thousands of Dollars)

| | FY 1979 | FY 1980 | FY 1981 |
|---|---|---|---|
| AERONAUTICAL RESEARCH AND TECHNOLOGY | 264,100 | 308,300 | 290,300 |
| Research and technology base | 109,700 | 119,000 | 131,100 |
| Systems technology programs | 154,400 | 189,300 | 159,200 |
| (Aircraft energy efficiency technology included in systems technology) | (97,400) | (116,100) | (85,000) |
| SPACE RESEARCH AND TECHNOLOGY | 107,300 | 115,800 | 115,200 |
| Research and technology base | 86,277 | 99,785 | 103,400 |
| Systems technology programs | 12,023 | 11,015 | 9,700 |
| Standards and practices | 9,000 | 5,000 | 2,100 |
| ENERGY TECHNOLOGY | 5,000 | 3,000 | 4,000 |
| TOTAL AERONAUTICS AND SPACE TECHNOLOGY | 376,400 | 427,100 | 409,500 |

SPACE TRACKING AND DATA SYSTEMS

| | | | |
|---|---|---|---|
| TRACKING AND DATA ACQUISITION | 299,900 | 332,400 | 359,000 |
| Operations | 249,903 | 264,500 | 271,500 |
| Systems implementation | 40,497 | 57,300 | 76,200 |
| Advanced systems | 9,500 | 10,600 | 11,300 |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 CONSTRUCTION OF FACILITIES PROGRAM

BUDGET PLAN
(Thousands of Dollars)

PROJECTS BY INSTALLATION

| | |
|---|---|
| Ames Research Center | 13,180 |
| Construction of Man-Vehicle Systems Research Facility | 7,480 |
| Modification of Steam Ejector System and Thermal Protection Laboratory (N-234) | 2,300 |
| Modification of the Unitary Plan Wind Tunnel (N-227) | 3,400 |
| Jet Propulsion Laboratory | 3,500 |
| Modifications to Various Buildings for Energy Conservation | 1,500 |
| Modifications to Various Buildings for Seismic Protection | 2,000 |
| John F. Kennedy Space Center | 760 |
| Rehabilitation of High Temperature Hot Water System, Zone 2, Industrial Area | 760 |
| Langley Research Center | 22,756 |
| Modifications for Avionics Integration Research Laboratory (1220) | 5,756 |
| Modifications to Aircraft Landing Dynamics Facility (1257) | 15,000 |
| Rehabilitation and Modification of Gas Dynamics Laboratory (1247) | 2,000 |
| Lewis Research Center | 12,355 |
| Decommissioning of Plum Brook Station Reactor Facility | 3,000 |
| Modifications to Central Air System, Various Buildings | 7,655 |
| Rehabilitation of Electrical Switchgear, Engine Research Building 5 | 1,700 |
| Michoud Assembly Facility | 4,582 |
| Rehabilitation of Roof, Phase II, Building 103 | 3,800 |
| Rehabilitation of Chilled Water System | 782 |
| Various Locations | 2,150 |
| Modification of 26-Meter Antenna, DSS-44, Canberra, Australia (JPL) | 1,200 |
| Replacement of Azimuth Radial Bearing, DSS-14, Goldstone, CA (JPL) | 950 |
| Space Shuttle Facilities at Various Locations as Follows: | 10,100 |
| Modification of Manufacturing and Final Assembly Facilities for External Tanks (MAF) | 5,400 |
| Modifications to Solid Rocket Motor Manufacturing and Assembly Facilities, Thiokol Plant, Wasatch, Utah | 2,700 |
| Minor Shuttle-Unique Projects (Various Locations) | 2,000 |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 CONSTRUCTION OF FACILITIES PROGRAM

BUDGET PLAN
(Thousands of Dollars)

PROJECTS BY INSTALLATION

| | |
|---|---|
| Space Shuttle Payload Facilities at Various Locations as Follows: | 1,617 |
| Rehabilitation and Modification for Payload Ground Support Operations (KSC) | 1,617 |
| Repair of Facilities at Various Locations, Not in Excess of $500,000 per Project | 15,000 |
| Rehabilitation and Modification of Facilities at Various Locations, Not in Excess of $500,000 per Project | 20,000 |
| Minor Construction of New Facilities and Additions to Existing Facilities at Various Locations, Not in Excess of $250,000 per Project | 4,000 |
| Facility Planning and Design | 10,000 |
| TOTAL | 120,000 |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

BUDGET PLAN
(Thousands of Dollars)

| INSTALLATION | FY 1979 | FY 1980 | FY 1981 |
|---|---|---|---|
| Johnson Space Center | 152,930 | 162,881 | 170,688 |
| Kennedy Space Center | 123,314 | 131,861 | 141,385 |
| Marshall Space Flight Center | 149,007 | 157,599 | 160,377 |
| National Space Technology Laboratories | 4,488 | 4,899 | 5,108 |
| Goddard Space Flight Center | 127,910 | 135,805 | 139,335 |
| Wallops Flight Center | 15,806 | 17,085 | 18,977 |
| Ames Research Center | 62,712 | 69,801 | 71,469 |
| Dryden Flight Research Center | 19,068 | 21,702 | 21,681 |
| Langley Research Center | 106,643 | 116,040 | 119,145 |
| Lewis Research Center | 87,457 | 97,825 | 101,360 |
| NASA Headquarters | 84,473 | 90,688 | 97,629 |
| TOTAL | 933,808 | 1,006,186[a/] | 1,047,154 |

a/ Includes proposed supplemental of $46,286,000 to cover revised salary rates implemented in October 1979.

TOTAL NUMBER OF PERMANENT POSITIONS - END OF YEAR

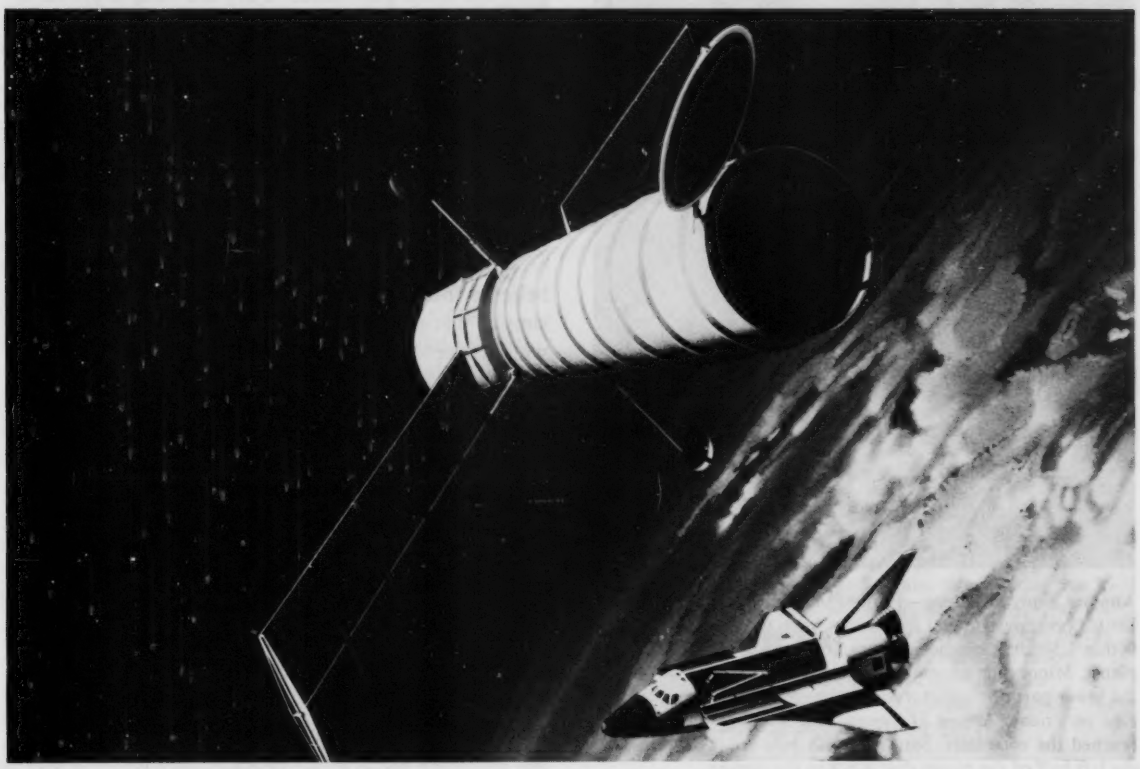
| | | | |
|---|---|---|---|
| Johnson Space Center | 3,504 | 3,469 | 3,494 |
| Kennedy Space Center | 2,193 | 2,191 | 2,201 |
| Marshall Space Flight Center | 3,636 | 3,561 | 3,561 |
| National Space Technology Laboratories | 104 | 103 | 103 |
| Goddard Space Flight Center | 3,482 | 3,440 | 3,440 |
| Wallops Flight Center | 398 | 395 | 395 |
| Ames Research Center | 1,666 | 1,658 | 1,658 |
| Dryden Flight Research Center | 480 | 461 | 461 |
| Langley Research Center | 3,005 | 2,980 | 2,980 |
| Lewis Research Center | 2,858 | 2,835 | 2,835 |
| NASA Headquarters | 1,505 | 1,520 | 1,585 |
| TOTAL | 22,831 | 22,613 | 22,713 |

## Search for Space Telescope Facility

Proposals for the establishment of a Space Telescope Science Institute facility in the United States were due by March 3 at Goddard Space Flight Center, Greenbelt, Md. The Institute will be a national facility for the receipt and evaluation of data from the 9,100-kilogram Space Telescope and is scheduled to be fully operational in the early 1980s.

Located on a site to be chosen by the contractor, the Science Institute will be responsible for selection and support of observers to use the telescope, for detailed science planning and scheduling, routine console operations, data archiving, calibration and analysis.

The contractor will staff the facility with scientists to manage the various science programs and perform related astronomical research. In addition, all personnel and facilities necessary to house and support principal investigators and general observers are to be provided. In addition, the winning contractor will staff and operate the Space Telescope Science Support Center (science control center) at Goddard.



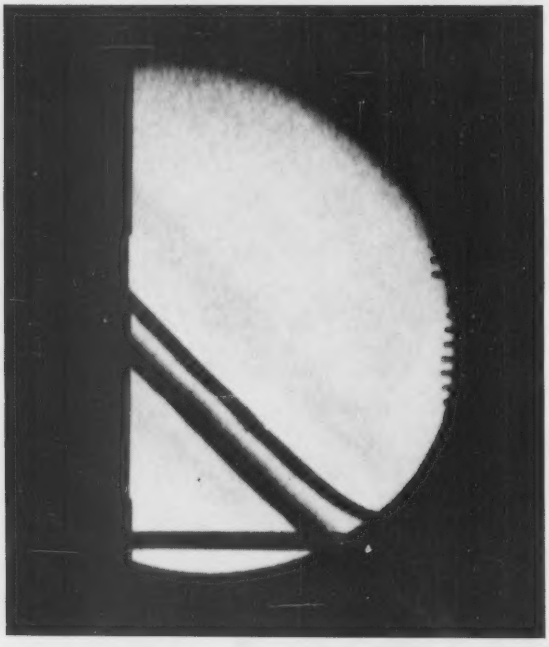
Artist's concept of the 2.4 meter Space Telescope after leaving the Shuttle Orbiter.

The 2.4-meter Space Telescope is scheduled to be placed in a 500-kilometer orbit inclined 28.8 degrees to the equator by the Space Shuttle in late 1983 or early 1984. Circling the Earth above the obscuring atmosphere, the telescope will observe some 350 times more volume of space than can be seen now from ground-based observatories.

Science and spacecraft data will be transmitted via a Tracking and Data Relay Satellite to the control center at Goddard and then sent on to the Science Institute for processing and analysis.

The telescope is expected to function at least until the end of the century. At about 30-month intervals, the Space Shuttle will visit the telescope in orbit where astronauts will perform maintenance and replace scientific instrumentation.

NASA's Marshall Space Flight Center is the project manager for the Space Telescope, and Goddard is responsible for management of the onboard science instrumentation and the Space Telescope Science Institute.



**Another Study of Saturn**—Further pictures by Pioneer show Saturn's ring system and its shadow when the spacecraft was within 1,500,000 kilometers from first encounter with the planet. Minor data anomalies appear as a dark band across the lower part of the pictures. The image was made at 7:32 a.m. on Friday, August 31, twenty four hours before Pioneer reached the encounter. Saturn's north pole is at 2 o'clock and the left half of the planet disc is not in the picture.

## 19-Year-Old NASA Flight Controller

When the manned Space Shuttle makes its first Earth orbital flight later this year, the flight data will be monitored closely by space flight controllers, including 19-year-old Jackie Parker. Jackie works in the data processing system at Johnson Space Center in Houston.

Being the agency's youngest flight controller could be trying, but it doesn't seem to rattle Ms. Parker. She's used to being the youngest. When she was only 13 years old, she was accepted at a North Carolina college. She was a college freshman at 14.

"My interests all along were in math, and flying and computer sciences," she said in a recent interview. "By the time I got to college and I realized that harder, more challenging things were very realistic for me, that's when I decided to go to work for NASA and to go further with my own interests."

The training is the hardest part of her job. It is a never-ending process, according to Jackie. Flight controllers are always learning, always studying. In selecting flight controllers, NASA looks for people with a technical background, either in education or in previous work experience. They are then assigned to work directly with a senior flight controller, learning the special peculiarities of the Mission Control Center and developing the capabilities and techniques necessary to the job.

Pete Frank, Chief of the Flight Control Division at Johnson says a good flight controller must have two main characteristics—technical expertise and the ability to apply that knowledge to actual operations.

The training is so detailed and thorough that Jackie believes the Space Shuttle mission will be relatively simple "because I think by that time, we will be very well prepared and we will have learned and built up confidence in our team."

What about the future? Where does a 19-year-old NASA flight controller look for her next challenge? Why, to space, of course. Jackie plans to be an astronaut. She believes that someday journeys into space will become routine and sees the conquest of space as part of humanity's eternal search for knowledge. "When we try to devise new technologies . . . we end up discovering many other things along the way. Now we have hundreds and hundreds of spinoffs from the past space programs and in the process of building the new Space Shuttle we have come across many other spinoffs that affect our everyday life in many areas. I can't think of one

area that NASA has not contributed to, and I don't think people are aware of that. And that's why I think the space program is important. It's not just exploring space . . . it is helping us live more comfortably, sustaining life longer and finding new resources."

In the meantime, Jackie Parker intends to continue trying to be the best flight controller she can be and an important part of NASA's next manned step in space.

Jackie Parker at her console in Houston.

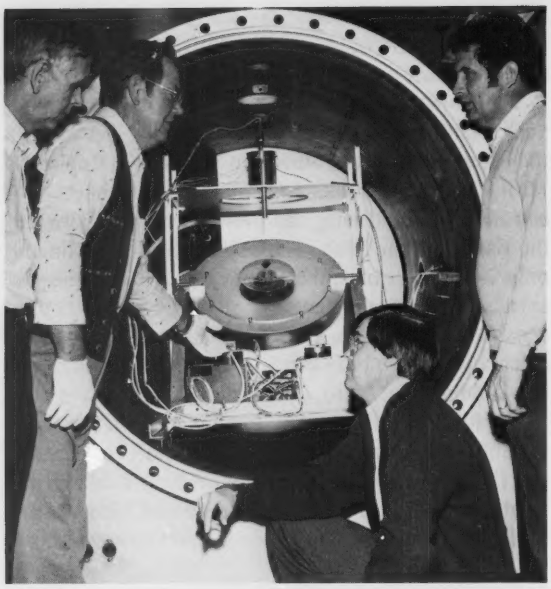
## Possible Astronomical Missing Link Found

California Institute of Technology planetary scientists have discovered an object orbiting the sun that may be the missing link between the class of asteroids that cross the orbit of Earth, and comets. It has been suggested by some scientists that many small asteroids that come close to the Earth are the remains of comets that have exhausted their volatile materials, which give them their characteristic diffuse heads—or comas—and tails.

The object was discovered by planetary scientist Eleanor F. Helin, assisted by Schelte Bus of Caltech, who have been engaged in a search for planet-crossing asteroids with Caltech Professor of Geology Eugene M. Shoemaker. The object was first detected in November 1979 on photographic plates taken with the 18-inch Schmidt Telescope at Hale Observatories' Palomar Moutain Observatory. Since then, other observations from around the world have been used to determine the object's orbit and physical characteristics.

The object, designated as 1979VA, orbits the Sun about every 4½ years, passing from just within the orbit of the Earth, almost to the orbit of Jupiter (from .98 to about 4½ astronomical units, one astronomical unit being the average distance between the Earth and the Sun). The object's orbit is inclined only 2.8 degrees from the ecliptic, the plane of the earth's orbit around the Sun. At discovery, 1979VA was about 13 million miles from Earth. Orbital calculations have been done by Brian G. Marsden of the Smithsonian Astrophysical Observatory, Cambridge, Mass., and Dr. James G. Williams of Jet Propulsion Laboratory. More than 20 observations from telescopes in the U.S., France, New Zealand, England, and the People's Republic of China were used in Marsden's calculations.

**Prize for Jupiter Prognosis**—Ray Reynolds, left, and Patrick Cassen, research scientists at Ames Research Center, pose with a picture of volcanoes erupting on Jupiter's moon, Io. In a NASA-Ames study, the two joined Stanton J. Peale, University of California, Santa Barbara, in predicting that Io had a molten interior and volcanic eruptions. Their scientific paper predated photographs of the Io eruptions taken by the Voyager spacecraft as it flew past the planet-sized moon. The three-man team has been awarded the American Association for the Advancement of Science-Newcomb-Cleveland prize for the prescient report.



**Dynamics Explorer Experiment**—Scientists and engineers at Marshall Space Flight Center's Space Science Lab examine a Retarding Ion Mass Spectrometer upon completion of its calibration tests in a vacuum chamber. The instrument will fly aboard the Dynamics Explorer satellite in 1981 to investigate the coupling of energy and particles between Earth's atmosphere, magnetosphere and ionosphere. Left to right are John Reynolds, Roy Hunt, Dr. C. R. Chappell (principal investigator) and Stanley Fields (lead engineer for SSL).

## Risk "Insignificant' With Carbon Fiber

A 22-month U.S. government/industry study has determined that the risk of electrical equipment damage from release of carbon fibers from a civil aircraft accident is insignificant.

Results from the NASA analysis were reported at a conference at Langley Research Center where representatives of several government agencies and private companies presented technical papers and oral reports on various aspects of continuing government study of the potential use of carbon fibers.

R. R. Heldenfels, Langley's Director for Structures, summarized the NASA study results by saying the public risk from using carbon fibers on current and future civil aircraft in the United States is so small as to be insignificant.

Carbon or graphite fibers are small-diameter filaments used to make composite materials. Composites are formed when fibers are embedded in a plastic matrix to form a solid material. Composites are being used increasingly in aircraft because of their high strength, durability, improved performance factors and lighter weight.

Composites are also used in many commercial products, from recreation to industrial equipment. With a growing demand for composites, the government became concerned about potential accidential release of the fibers. The perceived potential risk stems from the reaction of most composite structures to burning, which causes the composites to break down, releasing short lengths of fibers into the atmosphere. Considered to be highly heat-resistant and electrically conductive, the released fibers were first thought to be very damaging to electrical equipment. Because of their extreme lightness, fibers can possibly float for miles, settle on electrical equipment and sometimes cause short circuits or equipment malfunctions.

"The study had to be done," says Robert Huston of Langley, Manager of the NASA Graphite Fibers Risk Analysis portion of the goverment study. "If the earlier concern had materialized, there was a good chance that carbon fiber applications throughout the country would have been seriously impacted."

## Longer-Range, High Risk/Payoff Research Aim of NASA Lewis

A realignment of functions and capabilities to emphasize its current major research and technology roles in aeronautics, space and energy was announced in January by the NASA Lewis Research Center.

Lead center for NASA in energy conversion technology, Lewis said that all R&T (research and technology) programs are being regrouped under aeronautics, space and energy and that a fourth directorate—Science and Technology—is being established to facilitate longer-range, high risk/high payoff research.

Under the restructuring, Dr. John F. McCarthy, Jr., Lewis director, said Lewis would maintain and improve leadership as a premiere energy conversion laboratory.

"Ours will be a posture most responsive to the challenges of the future," he said.

"We will be able to better utilize our in-house skills in a true across-the-board matrix fashion so that new technology that advances aeronautical propulsion can, for example, be readily considered for application to terrestrial energy projects," he explained. "By the same token, we will be better able to bring the advantages of space technology innovation to aeropro-

pulsion and terrestrial energy needs of the nation."

Among current Lewis objectives in terrestrial energy, he listed efforts to bring wind energy systems to a competitive status costwise with fossil-fuel generating systems throughout the country; to further the use and improve the economics of solar cell (photovoltaic) energy systems as a supplementary or prime source of electric power in remote areas; and to advance the technology of alternative automobile engines and propulsion systems that would greatly conserve fuel, reduce pollution and have multi-fuel capability. All of this work, he said, is being managed by Lewis for the Department of Energy.

Among current aeronautical propulsion objectives, Dr. McCarthy cited programs underway aimed at developing more fuel-efficient, cleaner-burning and lower-polluting engines for aircraft of the mid-eighties and beyond. Aeronautical propulsion still represents approximately 40 percent of the center's work mix. More noteworthy space projects at Lewis coming under the new organization matrix would be the recently enlarged Lewis thrust in space communications and continuing strong participation in chemical and electric rocket development.

The new Science and Technology Directorate will be the largest of all the Lewis research directorates, he added. Dr. Seymour C. Himmel, associate director of the center, will retain those duties and serve as acting head of the new directorate.

Said Dr. Himmel:

"A number of advantages accrue to combining our generic disciplines in one management grouping. Concentration will be fixed on basics. It has become more and more evident that advances in technologies such as materials, structural mechanics, aerodynamics, acoustics, fuels and combustion, fluid and thermal processes, measurement, controls and electronics are not only critical to Lewis objectives but are relied upon by our country for its economic well being and and security.

"Also, a single management will serve as a focal point for the emergence and development of new ideas. It will emphasize the type of inhouse exploratory and innovative research in which Lewis has always excelled."

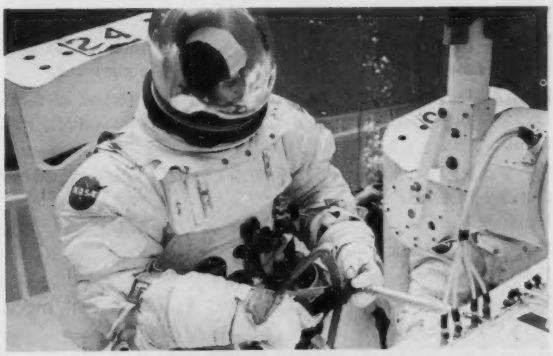
Previously, the Lewis organization format emphasized projects and programs with individual research and technology support. The realignment lays greater stress on technological innovation and makes such technological innovation more accessible to every project office.

## Contractor News

**Detroit Diesel Allison of Indianapolis,** a division of General Motors Corp., has been awarded a $65 million Federal contract for its automotive industry team to develop an advanced gas turbine engine for autos as an alternative to the spark-ignition (internal combustion) engine. The award was negotiated by NASA's Lewis Research Center, which managed several parts of the Department of Energy's Automotive Development program. The contract is cost-shared with no-fee and Detroit Diesel's cost share is $5.2 million.

**The Boeing Company** and Johnson Space Center have extended for 18 months their cost-plus-award fee contract for safety, reliability and quality assurance engineering support. The extension brings the total value of the Boeing contract to over $36 million.

**McDonnell Douglas Astronautics Co.,** of Huntington Beach, Calif., has received a letter contract from the Goddard Space Flight Center for fabrication and subassembly of vehicles for Delta launches 164 and 165; another letter contract from Goddard to McDonnell Douglas calls for long lead-time materials for Delta launch vehicles 166 through 170. Both are add-ons to existing fixed price contracts, the former in the amount of $2 million and the latter over $1 million. The work is to be performed at Huntington Beach and subcontractor facilities.



**Woman Astronaut 'Weightless'**—Dr. Shannon Lucid, a mission specialist astronaut, uses a power tool on the Space Telescope mockup in the Marshall Space Flight Center's Neutral Buoyancy Simulator, as part of a project for servicing the telescope in Earth orbit. Dr. Lucid, of the Johnson Space Center, recently became the first woman astronaut to work in the simulator. (Distortion caused by the curvature of the plastic helmet makes the astronaut's head appear smaller than actual.)

## Patents for Inventions from NASA Research

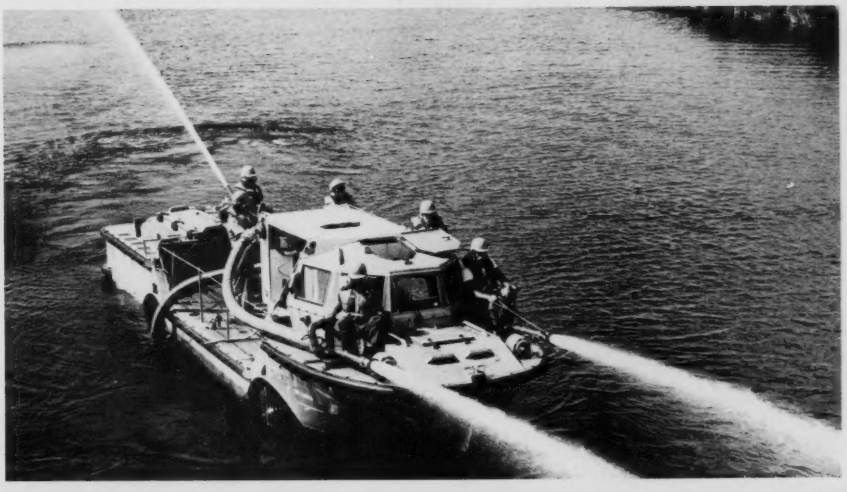
*The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.*

| Inventor(s) & Employer | Title | Patent No. | Installation |
|---|---|---|---|
| Rudolf A. Schindler ..... Caltech/JPL, Pasadena, Ca. | Over-under double pass interferometer ..... | 4,181,440 | NRO/JPL |
| Donald E. Brooks, Univ. of ..... Oregon, Portland, Or. | A method for separating biological cells ..... | 4,181,589 | MESC |
| Jack E. Cornett ..... Ralph C. Corley Thomas O. Fraley Andrew A. Saunders, Jr. General Electric Co. Cincinnati, OH. | Method and apparatus for rapid thrust increases in a .. turbofan engine | 4,184,327 | LeRC |
| John W. Vorreiter ..... NASA/Ames Research Center Moffett Field, Ca. | Cryogenic container compound suspension strap ..... | 4,184,609 | ARC |
| Paul B. Reese, David W. Murphy ..... Rockwell International Space Systems Group Downey, Ca. | A pressure limiting propellant actuating system ..... | 4,183,217 | MSC |
| Paul M. Sawko, Salvatore R. ..... Riccitiello, Charles L. Hammermesh Rockwell International 1,000 Oaks, Ca. | Ambient cure polyimide foams ..... | 4,184,021 | ARC |
| Gary B. Turner, Caltech/JPL ..... Pasadena, Ca. | Solar cell I-V curve driver ..... | 4,184,111 | NPO |
| John F. Holmes, Ronald T. Miles ..... Computer Sciences Corp. Applied Technology Division, Falls Church, Va. | Charge injection method and apparatus of producing .. large area electrets | 4,184,368 | MFS |
| Merle A. Economu, Gerald J. Baker, ..... NASA/Dryden | Air speed and attitude probe ..... | 4,184,149 | FRC |
| John S. J. Benedicto, Bruce E. ..... Woodgate, NASA/Goddard | Method and apparatus for slicing crystals ..... | 4,184,472 | GSC |
| William J. McGannon ..... NASA/Lewis | Intra-ocular pressure normalization technique and .... equipment | 4,184,491 | LeRC |
| Paul A. Dillard, Walter M. Fritz ..... Dan R. Lott, Lockheed Electronics Co., Sunnyvale, Ca. | Method of fabricating a photovoltaic module of a .... substantially transparent construction | 4,184,903 | NPO |
| Stephen R. Peck, Jeffrey W. Benham, .... General Electric Co. Philadelphia, Pa. | Voltage feed through apparatus having reduced ..... partial discharge | 4,185,164 | GSC |
| Wilford E. Siverston, Jr. ..... NASA/Langley | Radar target for remotely sensing hydrological ..... phenomena | 4,184,155 | LaRC |
| Maynard C. Sanford, David L. Gray ..... NASA/Langley | Solar cell angular position transducer ..... | 4,184,072 | LaRC |
| Randolf R. Culotta, Donald L. Posey, .... NASA/Langley | Static pressure orifice system testing method ..... and apparatus | 4,182,158 | LaRC |
| Milton H. Brockman, Mahlon F. ..... Easterling, (Caltech) JPL/Pasadena, Ca. | Radio frequency arraying ..... | 4,186,347 | JPL |

## Launches for 1980

| Name | Launch Date | Vehicle | Range | Mission Remarks |
|---|---|---|---|---|
| FLTSATCOM-C | January 17 | Atlas Centaur | ETR | DOD Navy. Reimbursable |
| SMM-A | February 14 | Delta | ETR | NASA. Scientific Solar Maximum Mission. |
| NOAA-B | May | Atlas-F | WTR | NOAA Weather. Reimbursable. |
| Navy-20 | July | Scout | WTR | DOD Transit. Reimbursable. |
| GOES-D | August | Delta | ETR | NOAA Weather. Reimbursable. |
| Intelsat V-A | September | Atlas Centaur | ETR | Intelsat communications. Reimbursable. |
| Navy-21 | October | Scout | ETR | DOD Transit. Reimbursable. |
| SBS-A | October | Delta | ETR | Satellite business systems. Reimbursable. |
| FLTSATCOM-D | November | Atlas Centaur | ETR | DOD Navy. Reimbursable. |
| Intelsat V-B | December | Atlas Centaur | ETR | Intelsat communications. Reimbursable. |

**Oblique Wing in Flight**—Dryden center cameras capture the AD-1 Oblique Wing Research Aircraft over the dry lakebed at Edwards, Calif. NASA Dryden civilian pilot Tom McMurtry is at the controls. The small, light-weight research plane is testing a pivoting-wing concept which may reduce noise and lower fuel consumption in future high-speed, transport type aircraft.



**Amphibious Firefighter Tested**—Members of the City of Miami Fire Department are shown using a lightweight firefighting module that evolved from pumps developed by the Marshall Flight Center for rocket motors. The unit is being tested aboard an amphibious vehicle obtained through government surplus. Miami firefighters say the configuration can be driven along the shoreline and into the canal and can pump up to 2,000 gallons of water per minute. The module was provided by Aviation Power Supply, in cooperation with NASA.

# Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

## Alaska Pipeline Insulation

Crude oil moving through the 800-mile Trans-Alaska Pipeline must be kept at a relatively high temperature—about 180 degrees Fahrenheit—to maintain the fluidity of the oil. In Arctic weather, that demands highly effective insulation. General Electric Co.'s Space Division, Valley Forge, Pennsylvania, provided it with a spinoff product called Therm-O-Trol. Shown being installed on the pipeline, Therm-O-Trol is a metal-bonded polyurethane foam especially formulated for Arctic insulation.

A second GE spinoff product, Therm-O-Case, solved a related problem involved in bringing hot crude oil from 2,000-foot-deep wells to the surface without transferring oil heat to the surrounding permafrost soil; heat transfer could melt the frozen terrain and cause dislocations that might destroy expensive well casings. Therm-O-Case is a double-walled oil well casing with multi-layered insulation which provides an effective barrier to heat transfer. Therm-O-Trol and Therm-O-Case* are members of a family of insulating products which stemmed from technology developed by GE Space Division in heat transfer/thermal control work on Gemini, Apollo and other NASA programs.

* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

***For the benefit of all . . .***

NASA
National Aeronautics and Space Administration

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